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DIALOG(R)File 624:McGraw-Hill Publications

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NEVADA PSC REHEARING ORDER PUTS TUSCARORA PROJECT BACK ON TRACK
Inside FERC October 10,1994; Pg 4
Journal Code: FERC ISSN: 0-163-948X
Section Heading: NEW GAS SERVICE
Word Count: 628

TEXT:
There was plenty of good news for Tuscarora Gas Transmission Co. in the decision by the Nevada Public Service Commission to modify an order issued earlier this year that contained various restrictions for Sierra Pacific Power Co.'s plans to take Canadian gas from the proposed pipeline project. By significantly altering its prudence finding and softening language on an interconnection between Tuscarora Gas Transmission Co. and the existing Paiute Pipeline Co. system, the PSC essentially ``opened the door for us to build the project," according to Ed Miller, Tuscarora's general manager.

In a March order that brought serious uncertainty to the financial viability of Tuscarora, the PSC vetoed half of Sierra Pacific Power Co.'s 90,000 Dt/day nomination for service from the new pipeline. It also directed Sierra Pacific Power -- the main Tuscarora customer and a sponsor of the project -- to pursue the interconnection. These findings were made in the context of Sierra Pacific Power's 1992-2011 Electric Resource Plan.

On rehearing, the utility and Tuscarora challenged the prudence finding, arguing, among other things, that through the use of released capacity, the utility can obtain upstream transportation on Pacific Gas Transmission Co. at a far lower cost than previously projected (IF, 6 June, 6). Parties also argued that a provision allowing the utility to **unilaterally vary** its **contract demand** level would undermine the financial integrity of Tuscarora and that the PSC lacked jurisdiction to order the interconnection.

In light of the new economics surrounding the project, the PSC in a Sept. 30 decision changed the basis of its prudence finding from an annual volume to a funding limit, asserting that Sierra Pacific Power can spend up to $19.3 million/year on transportation from Tuscarora and upstream pipelines. And if the utility spends more than that, it can come back in to the state commission to prove that the additional increment was prudently incurred and thus subject to passthrough.

The new approach ``gives us enough risk mitigation" to proceed with the project, Miller said last week. The utility ``will probably spend more per year in payments to the pipeline" but is ``confident that it can show any additional payments will be prudent," he related. Project sponsors have calculated that the utility can move as much as 80,000 Dt/day under the $19.3 million authorization. The key to the PSC's finding, according to Miller, is that it ``doesn't preclude (Sierra Pacific Power) from going above 45,000 Dt/day."

Another critical development for the Tuscarora sponsors, Miller said, was the elimination of the provision allowing the utility to change its CD level at will. The condition was simply unacceptable to the Tuscarora sponsors, he noted.

Finally, the commission restated the interconnection provision to make clear that it was directing Sierra Pacific Power to use its best efforts to urge the pipelines to interconnect in the interest of enhancing the utility's supply flexibility. The PSC ``cleared up the fact that it didn't have jurisdiction" over the pipelines, Miller said, adding that he was ``confident there will be an interconnection."

Given the PSC's change of heart, Tuscarora expects to keep pace with its original timetable, according to Miller. Ferc's environmental review of the project (CP93-685) continued throughout the impasse over the PSC ruling, and a draft environmental impact statement is expected to be released late this month, he said. And with the PSC order in hand, the sponsors in the next week or so will urge Ferc to resume work on the nonenvironmental aspects of the plan. Tuscarora is hoping for final Ferc certification by March and commencement of service in November 1995, Miller said, noting that the company solicited bids for pipe two weeks ago. ``We're still targeting November (1995), and right now we see nothing that will cause a slip" in that schedule, he said.

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"would further degrade the quality of Tennessee's existing firm services by allowing additional interruptible volumes to utilize capacity that would otherwise be available to firm customers to increase takes during the day" up to maximum entitlements. It called the filing "a prime example of the type of activity that (a straight fixed-variable) rate design encourages but which the commission must guard against. Pipelines must not be able to undermine the quality and reliability of firm services in order to derive incremental revenue from interruptible customers." Tennessee would be "effectively double-booking a portion of the firm capacity now dedicated to providing firm customers the flexibility to make mid- and intraday nomination changes," Con Ed maintained.

Con Ed also is disgruntled that shippers would not be treated equally in other ways. It has flow control and must schedule volumes on a uniform hourly basis as nearly as practicable. It's unhappy that Tennessee allows New England customers with pressure control to take up to 6% of daily volumes in an hour, vs. the 4.17% allowed on a uniform hourly basis. Now, IT-X customers would be subject to a uniform hourly flow requirement -- but because they would have no **firm contract demand** , they could **vary** hourly nominations by large amounts, "circumvent entirely" the uniform flow requirement and have an unduly discriminatory advantage over **firm** shippers, Con Ed asserted.

The Tennessee Valley Municipal Gas Assn., too, protested that the IT-X hourly scheduling right "strips firm shippers of their priority and extends it to the service which the firm shippers, through their demand charges, subsidize."

The power-generation community is divided. The Fuel Managers Assn., which represents nonutility developers, applauded the proposal. But J. Makowski Associates, which operates four nonutility projects, said the 60%-load-factor rate is excessive and should be no higher than a 100%-load-factor rate. Since IT-X service has the lowest scheduling priority, it "is inferior to Tennessee's firm service and should be priced accordingly," J. Makowski said. And since Tennessee already accepts hourly nominations for firm shippers in some instances, "the additional administrative burden for scheduling hourly nominations under rate schedule IT-X will be minimal at most," it added. The Process Gas Consumers Group also endorsed a rate no higher than a 100%-load-factor rate.

New England Power Co. holds firm capacity on Tennessee, at high incremental rates, with the right to only a midday nomination change. Tennessee should be required to provide intraday scheduling flexibility to all firm customers, including those like NEPCO under individually certificated transportation, before being allowed to market IT-X service, the electric utility said. It also called the 60%-load-factor rate "clearly excessive" and advised a 100%-load-factor rate as the maximum.

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NORTHWEST DID NOT COMPLY WITH THE ORDER APPROVING NEW STORAGE

Inside FERC May 14, 1990; Pg 11
Journal Code: FERC ISSN: 0-163-948X
Section Heading: Pipelines

Word Count: 409

TEXT:
NORTHWEST DID NOT COMPLY WITH THE ORDER APPROVING NEW STORAGE services, Northwest Natural Gas Co. said late last month in asking the commission to delay the start of the pipeline's storage open season. But Northwest Pipeline Corp. and several other of the pipeline's customers urged the commission to disregard the arguments and recommendations set out by Northwest Natural.

In its March 14 order (CP88-651) certificating the storage services, the commission directed Northwest to offer interruptible as well as **firm** storage (IF, 19 Feb, 4b). The pipeline also was required to offer customers the option of establishing different **contract** - **demand** levels for the injection and withdrawal periods; a customer's **firm** capacity needs **vary** during those months, the commission explained.

Northwest Natural said in an April 30 protest that the pipeline's compliance filing "does not propose to provide any additional contract demand" to provide transportation service for storage customers. Northwest has at least 22,719 MMBtu/day of firm capacity to move gas withdrawn from the Jackson Prairie receipt point, it said. Northwest Natural suggested selling the available firm transportation capacity to storage customers "willing to pay demand or reservation charges for that service."

The proposal is "inconsistent" with the commission's open-access policies, Northwest replied. Washington Natural Gas Co., Intermountain Gas Co., Cascade Natural Gas Corp. and Washington Water Power Co. said "there is no logic for such a requirement," adding that "the paramount failure in Northwest Natural's theory is the faulty assumption that additional firm transportation capacity is available on a year-round basis" on Northwest. The distributors noted that many of the pipeline's customers have confirmed that Northwest "has no additional firm transportation capacity available in the winter."

The Northwest Industrial Gas Users agreed that there "is currently no new firm transportation capacity available" on Northwest. Customers not able to secure firm transportation capacity to facilitate storage withdrawals "should not, however, be foreclosed from obtaining firm SGS-2 storage service and having the gas transported to and from the Jackson Prairie storage field on an interruptible basis," the industrials said.

Customers willing to sign agreements for interruptible transportation of storage volumes "should not receive a lesser service priority" than the distributors that control the firm transportation CD rights on Northwest, the industrials emphasized. And even if firm capacity opens up in the future, shippers "should be allowed to put themselves at risk for not being able to obtain deliveries . . . during peak periods, but to pay a lower price for this service."

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TENNESSEE'S FIRM SHIPPERS WON'T TAKE BACK SEAT TO POWER GENERATORS
Inside FERC April 18, 1994; Pg 11
Journal Code: FERC ISSN: 0-163-948X
Section Heading: NEW GAS SERVICE
Word Count: 879

TEXT:
Shippers on Tennessee Gas Pipeline Co. don't agree on who would fare better under the pipeline's proposed new rate schedule geared to electric-power generators. Some firm customers believe that the interruptible power-generation shippers would gain an edge, while power generators think they would have to pay too much.

Tennessee proposed the IT-X rate (RP94-187) as a way to give power generators the flexibility they seek by permitting hourly scheduling changes. No IT-X nomination could bump any firm or interruptible service already scheduled and flowing on that day. To be compensated for what Tennessee says would be additional demands above its usual interruptible service, it would charge a 60%-load-factor derivative of its firm transportation rate (IF, 28 March, 1).

In comments earlier this month, firm customers contended that their flexibility to use space they are paying for would be reduced, to Tennessee's financial benefit. Firm shippers on Tennessee have the right to make a midday nomination change and, in some restricted circumstances, to make hourly changes. But under Tennessee's "no-bump" rule, no midday or intraday change can bump a service already scheduled and flowing.

The problem for firm shippers arises if they don't schedule their full contract volume initially but later in the day want to use the rest of their capacity and can't because of the no-bump rule. During the past winter, the New England Customer Group said, its members ran into that situation and as a result had to choose between exceeding nominated quantities and paying an overrun penalty of $15/Dt or using much more expensive peak-shaving facilities. The IT-X proposal "will exacerbate New England's concerns and further degrade" firm service by "adding another entry to the list of interruptible services that cannot be interrupted during the gas day by firm shippers," the group said.

Moreover, the IT-X shippers' hourly scheduling flexibility would increase the chance that a firm shipper wouldn't be able to increase its nomination during the day, the customer group said. For instance, if an IT-X shipper nominates at noon and a firm shipper tries to increase its nomination an hour later, the IT-X shipper gets priority. If Ferc approves the new schedule -- which should be treated as a certificate application, not a rate filing -- it should allow firm shippers to make midday and intraday nominations even if IT-X service is bumped, said the New England customers. The group conceded the "anomalous" result of that approach would be to bump higher-paying IT-X customers while interruptible shippers are protected but said "the proper solution lies in outright elimination of the 'no-bump' rule."

Consolidated Edison Co. of New York Inc. agreed that the IT-X service

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DIALOG(R)File 347:JAPIO

03412668 **Image available**
ADJUSTING SYSTEM OF RATE USING PORTABLE STORAGE MEDIUM

PUB. NO.: 03-075568 [JP 3075568 A]
PUBLISHED: March 29, 1991 (19910329)
INVENTOR(s): FUKUSHIMA MITSUAKI
WAKE SHOJI
TORII HISANOBU
APPLICANT(s): OSAKI ELECTRIC CO LTD [358680] (A Japanese Company or Corporation), JP (Japan)
TOKYO ELECTRIC POWER CO INC THE [330194] (A Japanese Company or Corporation), JP (Japan)
APPL. NO.: 01-211474 [JP 89211474]
FILED: August 18, 1989 (19890818)
INTL CLASS: [5] G01R-011/00; G01D-004/00
JAPIO CLASS: 46.1 (INSTRUMENTATION -- Measurement)
JAPIO KEYWORD:R088 (PRECISION MACHINES -- Automatic Vending Machines); R131 (INFORMATION PROCESSING -- Microcomputers & Microprocessers)
JOURNAL: Section: P, Section No. 1217, Vol. 15, No. 242, Pg. 54, June 21, 1991 (19910621)

ABSTRACT

PURPOSE: To enable exact and efficient execution of various processings including load survey by storing prescribed information (e.q. revison of a rate) in a portable storage medium and by conducting processings (e.g. processing of an amount of money) in accordance with this stored information.

CONSTITUTION: When the power rate is altered, for instance, a master card (magnetic card) 11 wherein a new rate and a date of execution of alteration are stored is prepared by an electric power company 1. Taking this card with him, a company's stuff in charge goes to a device 3 on each user side and makes a card reader/writer R/W (constructed for the magnetic card) of an reset unit 25 read the contents of the card, which are stored in RAM. Thereby the rate is altered automatically from the date of execution of alteration under the control of CPU of the reset unit 25. When the user desires that a **contract demand** be **altered**, he brings his customer card 13 to a rate card distributor 5 and has the card 13 rewritten as to the content of the contract demand. This card 13 is made to be read by the R/W of the reset unit 25 of the device 3 on the user's side. The **contract demand** is **altered** from a time point when the card is read. Based on the **altered demand**, the CPU controls a circuit breaker 23.
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Japanese Energy Security and Changing Global Energy Markets: An Analysis of Northeast Asian Energy Cooperation and Japan's Evolving Leadership Role in the Region

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The Center for International Political Economy
and
The James A. Baker III Institute for Public Policy
Rice University - May 2000

Reform of the Electricity Supply Industry in Japan

by:

Peter Hartley
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Abstract

Proposed reforms of Japan's electricity supply industry are quite modest by international standards. In particular, while the retail market has been the focus of reform efforts, the wholesale market has been largely ignored. Most of the gains from reforming electricity supply in other countries have arisen, however, from exploiting technological changes that have allowed wholesale markets to become more competitive. The electricity market in Japan currently is very heavily regulated, with pricing, entry and planning conducted in a centralized fashion. Japanese electricity prices are very high by world standards and also do a poor job of signaling the resource costs of meeting the demands of consumers, or the value of supply to potential producers. Japan will be making increasingly larger sacrifices of potential gains if it forgoes opportunities to radically restructure its wholesale electricity market in a manner consistent with world best practice. Successful restructuring requires an understanding of the sources of monopoly power in the industry, and separation of competitive from natural monopoly elements. Partial reforms that relax controls on the retail market while leaving monopolies in generation and transmission in place may be more harmful than beneficial.

Introduction

In the last decade or so, most OECD countries have undertaken extensive reform of their electricity supply industries. There are a number of explanations for this reform process. It is not simply a "fad" but reflects fundamental changes in the industry. If Japan does not choose to join this movement in a significant way, it is in danger of being stranded with an outdated industry structure that imposes severe costs relative to the best that is now attainable. Reform has to be done in the right way, however, because it is also easy to make the situation worse rather than better. In particular, while reform efforts in Japan thus far have focused on the retail sector, greater competition in generation is the major source of potential gains. There is little value in making retail markets more competitive, and reducing controls over retail prices, while monopolies at the wholesale level are left largely intact.

The electricity industry in Japan is heavily regulated and controlled by the central and prefectoral governments. Utilities must obtain permission from the Ministry of International Trade and Industry (MITI) to enter or exit the industry. Electric utilities cannot supply outside specified service areas, or enter into other businesses, without the permission of MITI. While independent power producers (IPP) selling output to utilities no longer need to obtain a permit from MITI, they are expected to sign a contract of at least ten year's duration. MITI also has to approve tariffs and other conditions of supply.

Tariffs are based on rate of return regulation using an accounting system specified by MITI. When an independent firm generates electricity at one location (for example from waste heat) for its own use at another location, MITI can order a utility to wheel the electricity across its network for a specified charge if the parties involved cannot reach an agreement.

MITI also regulates electricity supply reliability, voltage and frequency fluctuations, and safety. Plants have to abide by a restrictive maintenance schedule decreed by MITI. New plants have to be inspected and approved by MITI before they can begin operation. MITI also can order utilities to change proposed capital expenditure plans. The Electric Power Development Coordination Council, chaired by the Prime Minister, agrees annually on planned developments in the industry over the following 10 years. Utilities also cannot construct a new plant without an agreement from the relevant prefectoral governor.

The Japanese government currently owns two-thirds of the Electric Power Development Company (EPDC) (the main utilities share the remaining third). The EPDC owns and operates large-scale hydroelectric plants, geothermal power stations and some coal-fired plants totaling about 6% of generating capacity. Through EPDC, the government also owns a share of the Japan Atomic Power Company. Local governments own and operate 34 public enterprises that generate and sell power to the nine main utilities.

The Japanese government also imposes tariffs on the import of oil for power generation. The revenue from these is paid as a subsidy to the domestic coal industry. Coal prices nevertheless remain high by OECD standards, and the electric utilities are required to buy domestic coal at a price that is approximately three times the price of imported coal. Taxes are also imposed on the use of natural gas for power generation.

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1 GOVERNMENT INVOLVEMENT IN THE ELECTRICITY INDUSTRY

Japan is not alone in regulating its electricity supply industry. Many other countries have gone further and supplied electricity using a vertically integrated monopoly public enterprise under the direct supervision of a government minister. In these countries, the government also determines tariffs, while all investments are financed by government-guaranteed debt and directly approved by the cabinet.

Other countries, including the U.S., have, like Japan, relied primarily upon privately owned utilities to supply electricity. Although governments also regulate electric utilities in the U.S., the degree of government control over the industry is less extensive than it is in Japan. Furthermore, many states in the U.S. have, in the last decade, begun to reform their electricity supply industries by introducing greater competition, encouraging more extensive trade in electricity and using wholesale markets to set prices.

Since governments have intervened in the electricity industry in so many countries, one is led to ask whether the industry has particular characteristics that make it unsuitable to be operated on a competitive basis. If there are good reasons for government involvement in the industry, one should perhaps be cautious about reforms that reduce the government role. The changing degree of government involvement in recent years also raises the question of what has changed in the industry. The answers to these questions have implications for the optimal policy for Japan to pursue in coming years.

The usual explanation of extensive government involvement in the electricity industry is that supplying electricity is a natural monopoly activity. If production by a single firm is less costly than supplying the same output with two or more firms then an unregulated competitive industry will tend to evolve toward a monopoly structure. When there is a sole supplier of a good or service, however, that supplier can, by restricting output, charge a price in excess of marginal cost. Since the value of the product to consumers can then greatly exceed the costs of producing it, the outcome will be inefficient. As we argue further below, monopoly control of a "bottleneck" facility, such as a transmission network, can produce particularly large inefficiencies.

It has also been suggested that there are lesser, but nonetheless non-trivial, monopoly problems associated with electricity generation. We shall argue that this notion may be mistaken in so far as it is often based on a flawed econometric model of the production process. Even so, economies of scale in the construction of new generating capacity imply that the capacity expansion path in a competitive industry is probably less than the most efficient imaginable.

Nevertheless, natural monopoly characteristics of electricity supply cannot by themselves explain greater government involvement in this industry. After all, the notion that governments intervene in economic activity in order to increase efficiency conflicts with other evidence such as the propensity of governments to impose tariffs. We will argue instead that political intervention is targeted at other goals. Inefficiencies associated with a competitive electricity market may reduce the opportunity cost of government intervention, however, and thus could help to explain why intervention occurs more frequently in that industry.

When the efficiency of competitive outcomes increases, the opportunity cost of government involvement also increases. We shall argue that competition between electricity generators has recently become more feasible and more effective at delivering lower costs and prices and better customer service. Perhaps as a result, many countries – including the U.K., Argentina, Chile, New Zealand and Australia – have restructured and privatized their electricity supply firms. Substantial restructuring has begun even in the U.S. where private firms dominate. Several states are establishing competitive wholesale electricity markets and asking utilities to divest themselves of generating plants and surrender control of their transmission network.

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1.1 Economies of scale in electricity supply

Many recent reforms have drastically reduced the vertical integration of the electricity supply industry. While technological changes have facilitated this trend, another influence has been a better understanding of the economic conditions of the industry. A critical issue is the extent to which the electricity industry displays economies of scale, or in other words, whether costs increase more or less than output as output expands. We examine this question by looking at the technologies involved in supplying electricity.

Firms using technologies that exhibit increasing returns to scale do not necessarily experience lower costs as output expands. Firms combine many activities, each of which uses a technology with different economies of scale. For example, management and supervision are part of the activities of every firm. Managers need to acquire information, give directions to employees, ensure that directions are complied with and so forth. These activities are likely to exhibit decreasing returns to scale. The overall economies of scale depend on the mix of activities, and how that mix varies as output expands.

1.1.1 Operating economies of scale

Electric utilities can often increase sales, the number of customers served, or the range of products supplied without increasing network capacity. Conversely, reductions in sales, customers, or product range do not usually allow the firm to save on capital costs. Capital investments represent a sunk cost that is irrelevant to the cost of marginal changes in output, so long as supply remains unconstrained by current network capacity. For short run changes in output, the service costs, which exhibit diseconomies of scale, are dominant.

The way new generating capacity is added to an electricity supply system accentuates the short run increasing costs. Most electricity systems experience substantial daily and seasonal demand fluctuations. Periods of peak demand may only last a few hours each year. Plants used only in peak periods therefore usually have a low capital cost but, in consequence, a high operating cost. In fact, the construction of base load capacity is justified only when the saving in fuel and other operating costs over the expected life of the plant has a present value sufficient to compensate for the large initial capital costs. Thus, gas turbines are less expensive to build than large coal, oil or nuclear base load plant but use a premium fuel. Similarly, in a mixed hydro and thermal system, the "fuel cost" of hydroelectricity is the opportunity cost of the stored water. Consequently, hydro capacity should be used in peak periods when the cost of thermal generation would otherwise be higher.

Older, higher cost plants are also used to produce higher levels of output. Newer plants often embody technological advances that reduce operating costs. The maintenance costs, and lost time for maintenance, for older plants are also higher.

The result of these factors is that increases in the output of electricity in the short run are accompanied by rapidly rising marginal costs. Empirical analyses claiming to reveal increasing returns to scale in supplying electricity invariably include capital as a factor of production, and thus implicitly examine a long run supply function.

For electricity distributors, metering of use, repairing equipment, processing bills, and responding to customer complaints are significant components of total cost. These are all labor-intensive activities that exhibit decreasing returns to scale. Furthermore, as a network expands geographically, travel costs become a larger part of the cost of both metering and fault repair, raising the average costs of service. To offset some of these costs, the firm can establish regional offices. However, this increases the number of organizational layers and thus is likely to raise service costs per unit of output supplied. An increase in the number of customers of an electricity utility is also likely to be associated with an increase in the proportion of small customers, and an increase in the proportion of customers located in sparsely populated regions. Both of these factors will increase the average costs of supply as output expands.

1.1.2 Investment economies of scale

The fact that new generating capacity is added in "lumps" indicates that investment in new capacity, in contrast to expanding output using a given capacity, is characterized by economies of scale. Many of the

costs of adding to existing capacity, such as site preparation, engineering design, arranging transport of materials, procuring construction equipment and, to a lesser extent, the construction time, do not depend greatly on the size of the capacity increment. By delaying construction of a new plant, a larger plant size is warranted, allowing lower average construction costs per MW of generating capacity.

Economies of scale in the investment process do not imply economies of scale in the production of output using a given capacity. Econometric analyses that include capital along with fuel and labor as factors in a "timeless" production process will misconstrue the economies of scale in electricity generation. Investment in new generating capacity, and the production of output from a given capacity, ought to be treated as two separate production processes.

Economies of scale in the production of new generating capacity provide *no justification whatsoever* for combining existing generating plants to produce a small number of firms. There would be *no* reduction in costs resulting from such a combination. The ostensible benefits from exploiting economies of scale are illusory. On the other hand, if only a few firms own most of the capacity, the firms will have an incentive to restrict output relative to the available capacity. The result will be, as happened in the U.K., inefficient use of existing capacity and an artificial stimulus to investment. As a general rule, when restructuring the electricity supply industry, the aim should be to maximize the extent of competition by dividing the existing generating capacity between as many firms as possible.

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1.1.3 Network economies of scale

Supplying electricity across an integrated network requires coordination and scheduling of suppliers for technical reasons and also to minimize costs. "Command and control" mechanisms within a firm may be more effective than decentralized market processes at scheduling and coordinating supply from many disparate plants. Furthermore, if existing customers require additional electricity, or additional customers in a given area wish to take electricity service, it usually will be cheaper to use the existing network rather than duplicate that infrastructure. In many cases, additional service can be supplied without requiring any expansion in the existing trunk network. Many draw the inference, therefore, that an electricity network will be operated at lowest cost when one firm owns it.

Economies of scale in supplying distribution networks are pervasive. It will usually be prohibitively expensive to duplicate an existing distribution network in order to extend supply to new consumers. The main historical instances of an entrant producing a new network to partially replace an existing one have involved exploitation of new technologies. Consider, for example, the telecommunications market in the U.S.:

- MCI entered the long distance market by being the first firm to exploit microwave technology in place of land lines;
- U.S. Sprint based its entry into the same market on providing an entire network based on optical fiber;
- cellular telephones based on satellite and radio technology have permitted competition in the local phone market; and
- new technology may allow cable TV operators, and even electricity distributors to enter the local telecommunications market in the U.S..

New technologies might also allow electricity distribution networks to be bypassed. For example, in June 1998, Plug Power (http://www.plugpower.com/) introduced the first home to be supplied with its

total electricity needs by a fuel cell. Commercial production of this system is planned for the year 2001.

New entrants have also found a niche in many network industries by providing service to a different geographical area. For example, early competitors in the telephone industry in the U.S. often supplied service to the less densely settled suburban and rural areas that had been ignored by the Bell companies.

Networks have also been duplicated. At the end of the nineteenth century, competing local telephone networks, each using the same technology, served many cities in the U.S.. Lubbock, Texas still has two competing local electricity distributors with duplicate sets of wires. In Australia, the telecommunications carriers, Telstra and Optus, are currently constructing duplicate fiber optic networks.

Nevertheless, the strong economies of scale associated with the planning and operation of networks imply that these are in most cases likely to be a monopoly. The monopoly network is the critical factor that differentiates electricity supply from other large manufacturing activities, such as petrochemicals, automobile manufacturing, steel production, aluminum refining and so on. While these latter activities are operated as normal businesses in most countries with a number of competing private firms operating under at most light-handed government regulation, electricity supply, telecommunications and other "network industries" tend to be heavily regulated.

Many countries that have recently reformed their electricity supply industry have introduced regulations to constrain the abuse of monopoly power by network owners and to facilitate competitive access to transmission and distribution networks. In the U.S., reform of the electricity supply industry really began when the Federal Energy Regulatory Commission (FERC) encouraged the formation of regional power pools and interstate trade in electricity. As part of this process, utilities were required to implement transparent processes for determining wheeling charges for transmitting power from a competing utility to a customer in a different region.

There is room for debate, however, about the effectiveness of access regimes. Regulated access prices are inevitably based on arbitrary cost allocations and accounting conventions. Also, the firms operating the network often have proprietary information and can shift costs from other components of their business to the network operations. It is thus often very difficult to ensure non-discriminatory access and effective competition.

New Zealand has taken the view that monopolistic behavior of the wires business is highly circumscribed by the ability of customers to by-pass their host distributor through an effective access regime. In New Zealand there is now virtually no regulation over the distribution of electricity apart from the general laws relating to anti-competitive behavior.

In most countries other than New Zealand deregulation of network industries has been associated with regulation specifically designed to restrict the abuse of monopoly power in those industries. For example, the U.K. introduced separate regulatory agencies for its telecommunications, electricity, water and gas industries after they were privatized. These regulatory structures need to be established before the industry is restructured. If they are not, private investment plans may be severely disrupted as firms can anticipate that some regulations will almost surely be introduced at some time in the future.

While the operation and planning of a network are characterized by economies of scale, we should note that the *construction* of new transmission or distribution lines does not display decreasing average costs. Engineering firms that compete for other large construction projects can also compete effectively for construction jobs in the power industry. Maintenance of the transmission and distribution network also could be organized on a competitive basis. While routine maintenance on a given power line might be

done at least cost on a single trip, and opportunities to share plant and equipment could provide some economies of scale, offsetting diseconomies in large firms imply that several firms could compete to provide maintenance service to any one utility.

A retailer may wish to remain responsible for maintenance, however, since customer's value reduced line outages, rapid fault repair, consistent voltage and other factors are dependent on line quality. Even so, some consumers are happy to take electricity service from a firm other than the owner of the local distribution network.

1.1.4 Vertical integration

While distribution networks are susceptible to monopoly control, many other aspects of infrastructure industries are conducive to competitive supply. Nevertheless, we typically find that the owner of the high voltage electricity transmission grid also generates all or most of the electricity supplied to that grid and supplies services to customers.

Cost savings from combining related activities might explain these outcomes. Yet it is hard to believe, for example, that the cost savings from combining electricity generation, transmission and distribution would exceed the cost savings from combining metering, billing and customer service for supplying gas, electricity and water services.

The network characteristics of infrastructure supply industries are a more plausible explanation for vertical integration. The network owner is both a monopolist to its consumers and a monopsonist for suppliers to the network. This "two-sided monopoly" can create large efficiency losses in a disaggregated industry. The monopoly network owner would maximize profits by equating the marginal revenue from sales to the marginal expenditure on the purchased inputs. As illustrated in Figure 1, the result would be an even larger restriction on output, and an even greater efficiency cost, than would ensue from a single monopoly supplier.

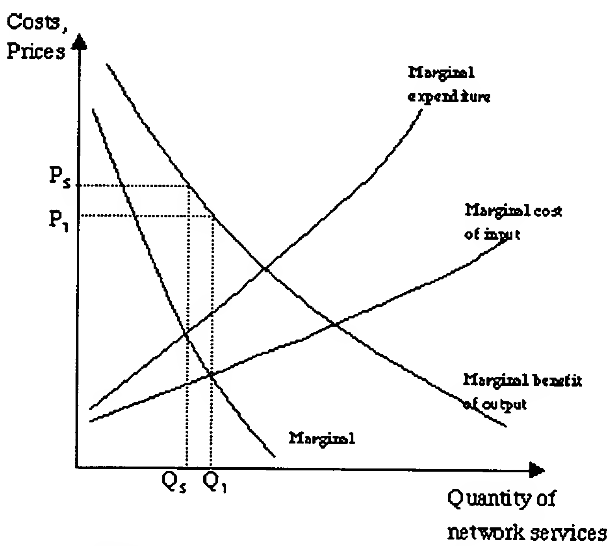

Figure 1: A monopoly network owner

In Figure 1, Q_I represents the output that would be produced by an integrated monopoly owner of both the generating capacity and the network, while P_I denotes the corresponding monopoly price. The lower output Q_S and correspondingly higher price P_S represent the outcome when a separate network owner is

both a monopsonist buyer from generating firms and a monopoly seller to customers.[1] A takeover of the suppliers by the network owner would not only lead to increased profits for the whole industry but also would benefit consumers. This is so even though the final monopoly outcome would still be inefficient.[2]

When the exercise of monopoly power by a network owner can be controlled, however, there may be significant gains from separating the potentially more competitive generating sector from the transmission and distribution parts of the business. This has been the philosophy behind the recent reforms in Australia, New Zealand, Argentina and the U.K., although the promotion of competition has been taken furthest in the state of Victoria in Australia

1.1.5 Geographical integration

The economies of scale associated with operating a local distribution network are often limited geographically. For example, as repair crews travel greater distances average costs increase. Even when a single firm owns a more extensive network it often splits operation and maintenance into semi-autonomous regional divisions, which could be run as separate firms without sacrificing economies of scale. Indeed, in the case of Japan, the electrical network is already divided along regional lines with a monopoly network owner in each region.

There are a number of advantages of having multiple firms, even if each firm is a regional monopoly. For one thing, it provides potential competitors to take advantage of any access opportunities that may arise through changes in regulations. Geographical separation also allows the operating costs in the different divisions to be compared with each other and eases the task of regulating firms. This "yardstick competition" has recently been instituted in Japan.

1.1.6 Contracting out

Contracting out, or competitive tendering, can also be seen as a type of "functional separation." For example, the firm operating the high voltage electricity network and planning network expansions does not have to construct or maintain the system.

A potential problem with mandating contracting out is that economies of scope (or cost savings from combining a number of separate activities in one firm) might be sacrificed. Another problem is that some activities that could be contracted out may be a critical component of service quality. For competition to produce the best outcome for consumers, it may be important for firms to retain control of these service dimensions.

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1.2 Problems with government intervention or control

We conclude that there is a possibility that competitive supply of electricity by unregulated private firms could be inefficient. In particular, economies of scale associated with the operation of electricity transmission and distribution networks imply that a completely unregulated industry is unlikely to achieve an efficient outcome. It does not follow, however, that government ownership, or even government regulation of a predominantly private industry, will necessarily produce a more efficient outcome.

1.2.1 The importance of information

Maximization of the gains from exchange requires accurate information on the values of goods or services to consumers. It also requires accurate information on the costs producers incur, which, in turn, depend on the values attached to alternative uses of particular resources. Generally, many different people each know only a small part of this mass of information.

In some situations, potential alternative suppliers, or levels of output, are relevant considerations. In these cases, parties other than the actual or potential market participants who are contemplating changing their behavior may have no reasonable way of assessing the hypothetical benefits or costs of altering current arrangements. For example, a customer may be considering new capital equipment that has electrical characteristics that differ from the existing equipment. Only the customer may know the relevant trade-off between electricity costs and other cost components. Similarly, a firm contemplating co-producing electricity with some other product may be the only party knowing the costs and benefits of alternative courses of action.

In a market economy, individuals have an incentive to transmit private information to other decision-makers by responding to prices. The prospect of gains from trading exclusive rights to use and to transfer resources, and to deny access to others in the absence of agreed payments, prompts individuals and firms to reveal cost and benefit information. Prices therefore signal the value of producing goods or services to firms, and the costs of meeting demands for goods or services to consumers.

Information on current and future costs or benefits is usually unavailable to bureaucratic planners operating under "command and control". The disparate individuals who know costs or benefits often have no incentive to reveal what they know, and may even have strong incentives to conceal their knowledge. Thus, in general, markets utilize more accurate cost and benefit information than will be available to bureaucratic planners.

Government-owned enterprises are notorious for their inefficiency. Employees know much more about the operations of the firm than do their political overseers. Unlike the owners of a private firm, politicians do not stand to gain financially by pressuring managers to run a firm more efficiently.

Differences in the information available to market participants and outsiders is a problem for regulated industries. Regulated firms retain strong incentives to maximize the benefits accruing to employees and shareholders. Employees typically know much more than the regulator about the details of the firm's operations, including real costs (as opposed to costs reported in accounting earnings and other measures), alternative ways of operating the business and opportunities for potential cost savings. Thus, for example, if regulated prices are based on a rate of return on invested capital, the firm has an incentive to artificially increase the capital intensity of its operations. Managers and employees also have an incentive to pay themselves higher wages or other benefits, or increase staff numbers above efficient levels, if the regulator simply passes on increased costs to customers in the form of higher prices.

In all regulatory regimes, including the Japanese one, the regulator attempts to reduce these information differences by requiring the regulated firms to observe restrictive and tightly specified accounting and other reporting conventions. The regulator can also compare different firms in similar circumstances to try to discover if one firm is less efficient than the rest. These techniques are imperfect, however, and economists have uncovered evidence that regulated firms tend to be run less efficiently than unregulated firms in a competitive market. Very rigid reporting and operating rules also often reduce the flexibility of management to take advantage of opportunities to reduce costs or increase benefits.

Regulation also tends to be much more feasible and effective in an environment where technology and

market participation are relatively static. Past information becomes a much less reliable guide to optimal current behavior when market conditions are changing. Regulators may find it particularly difficult to determine when it may be efficient to allow new firms to enter the market. It is striking, for example, that apart from the special case of Okinawa, MITI has not licensed a single electric utility supply business since 1951.

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1.2.2 Incentives to respond to information

Efficient utilization of resources requires decision-makers to respond to cost and benefit signals. This is rarely a problem with private firms operating in competitive product and financial markets. In joint stock companies, share prices provide an easily observed and current source of information about managerial performance. The ability to purchase ownership shares and mount a take-over also encourages managers to provide a competitive return to shareholders. Managerial rewards and sanctions thus are closely linked to responsiveness to cost and return signals.

There is an important corollary to the argument that share market competition assists in enforcing privately owned firms to be economically[3] efficient. Measures that limit the ability of shareholders to mount a takeover offer and install new managers of the firm may tend to reduce efficiency. Managers are under less pressure to minimize costs, or provide benefits to their customers. The less competitive market for ownership in Japan compared to countries such as the U.S. or the U.K. probably reduces the economic efficiency of Japanese firms relative to their counterparts in the U.S. or the U.K..

The effect of weaker incentives to reduce costs can be seen most dramatically in the case of enterprises owned by governments. While politicians have an incentive to monitor the performance of public sector managers, they are usually more concerned to ensure politically powerful interest groups are satisfied than that resources are not wasted. The link between inadequate returns on public sector investments and a politician's re-election chances are too weak to make cost minimization a prime target of political oversight.

Managers in the private sector also have an incentive to increase revenues as well as reduce costs. Their remuneration typically reflects both types of changes in company fortunes. By contrast, high information costs in the political marketplace typically mean that public sector managers receive much less from making good decisions than they pay for decisions that, with hindsight, turn out to be mistakes. This particularly applies to bad decisions with immediate and obvious costs, or good decisions with indirect or delayed benefits.

The excessive costs in enterprises that are owned or heavily regulated by governments take a number of forms. Since a government can legislate to attenuate competition, there is an understandable tendency for employees to seek, and obtain, a security of tenure that would not be possible where rival suppliers of the service may arise. This security of tenure is likely to diminish incentives to perform. Government enterprises and heavily regulated utility firms are, in fact, notorious for harboring inefficient work practices. Costs that amount to "feather bedding" can often obtain legislative approval, particularly with threats of strikes in crucial monopoly service sectors. Politicians may also direct (or "encourage") public enterprises to favor particular suppliers of productive inputs. The beneficiaries will be a concentrated local vested interest with political influence. The costs will be difficult to associate with the non-competitive tendering process.

Very similar pressures apply to regulated private firms. Regulators may develop very close relationships

with the firms being regulated and often see themselves as defenders of industry interests within the government bureaucracy. This attitude is encouraged by exchanges of staff between the regulatory agency and the regulated firms.

The regulatory process also provides an avenue for politicians to interfere in the operations of firms in an attempt to promote political goals rather than cost minimization or attention to the demands of customers. Such interference is particularly likely when regulators have substantial control over the detailed operations of the firms, as in Japan. In recent years, the trend has instead been toward the use of light-handed regulation aimed at controlling prices but leaving detailed operational decisions to managers. When regulation takes a heavy-handed approach and controls many of the operating and investment decisions of the firms, regulated private firms begin to look and behave much more like government-owned enterprises. As just one instance of this tendency, the IEA (1999: 70) observes that regulations in Japan tended in the past to favor local suppliers to the electricity industry:

> Japanese utilities used to rely on a limited number of suppliers and only recently have been actively encouraging foreign participation in their equipment procurement tenders. Very high technical standards[4] for equipment compared with other countries force prices up and limit the number of competitors.

In this instance, new political imperatives (arising from international relations) may have produced the apparent policy shift, although the quoted passage hints that the policy changes may be more cosmetic than substantive.

The domestic coal industry has been a particularly favored supplier to the Japanese electricity industry. As the IEA (1999:130) observes:

> Power utilities are obliged to pay a fixed price for domestic coal, currently about twice the level of imported prices ... As in other IEA countries, the principal motive for coal subsidies appears to be to maintain regional employment.

The pricing of hydroelectricity in Japan illustrates another way an industry can be subsidized by government. The EPDC, two-thirds of which is owned by the Japanese government (the other third being owned by the nine main utilities), is the main supplier of hydroelectricity in Japan. About 60% of the hydroelectric capacity is pumped storage[5] with an average capacity factor[6] of 30%. The low capacity factor reflects the fact that the pumped storage is used to provide electricity only during peak periods. The IEA estimates that the cost of peak electricity in Japan (from sources other than pumped storage) is about ¥32 per kWh. The cost of the alternative source of supply to pumped storage represents the value of the hydroelectricity generated. The EPDC currently sells hydroelectricity at the average cost of production, however, which is ¥9 per kWh. This represents a subsidy to the electricity supply industry and undervalues new hydroelectric capacity, discouraging the development of new hydroelectric plants.

Regulations guaranteeing low risk and relatively assured profits may have another benefit from the perspective of politicians. The profits may become akin to a share of tax revenue to be dispensed to favored individuals in return for their political support.

1.2.3 Inefficient pricing

Efficient resource use is unlikely when prices for a marginal unit of consumption fail to signal marginal cost.[7] Yet prices for electricity supplied by monopoly public utilities, or prices regulated by public bodies overseen by politicians, typically show substantial deviations from marginal costs. For example, Japan has special higher tariffs for electricity used for lighting. Higher prices for lighting and other uses with a low elasticity of demand violate the principle that the same good should sell for the same price.

More generally, while the marginal cost of electricity supply varies by location and the system load at the time supply is drawn, tariffs typically vary by customer type, and the purpose for which electricity is used. Japan differentiates prices based on customer type and the voltage at which power is drawn from the grid. Different prices for different categories of customers are sometimes justified on the grounds that patterns of demand differ. Businesses purchasing electricity for lighting supposedly buy a greater proportion of their electricity during peak periods. However, higher prices for customer categories with higher peak demand do not give incentives for each user to economize on peak demand. Similarly, while customers drawing supply at higher voltages may save on some costs (such as the losses associated with transforming power to a lower voltage) the differential in tariffs typically exceeds the cost differences. In many cases, price differences appear to have at least as much to do with the elasticity of demand, and perhaps the political influence, of the user as with the costs of service.

The weak correspondence between costs of supply and electricity prices in Japan may be one reason for the very low load factor.[8] In fact, the load factor in Japan is one of the lowest among industrialized countries. Some of the utilities in Japan have introduced optional time-of-use rate packages, but such packages have affected less than 10% of the contracted capacity and the load factor has continued to deteriorate in recent years.

Monopoly government-owned, or heavily regulated, utilities also often underpay for electricity co-generated by private firms. In particular, the price paid for electricity supplied at a bulk supply point is typically far below the price charged for electricity taken from the grid at the same point. In Japan, industrial firms including steel makers, chemical companies, oil refiners, cement producers and pulp and paper companies produce about 28% of the electricity used by industry. Most of this production is consumed in-house, although some is sold to the local monopoly utility through joint venture arrangements. The 1995 amendments to the Electric Utilities Industry Law simplified the approval process for co-generators of electricity. Independent power producers (IPPs) are no longer required to obtain a permit from MITI before entering the business, but they are still required to sign contracts with the local utility of at least 10 years' duration. Both the steel and the petroleum refining industries have taken advantage of the new law to increase their co-generation capacity. Since the contracts between the utilities and the co-generators are commercially confidential, however, it is difficult to know whether the co-generators have been paid the opportunity cost of the savings they provide to the utilities. One suspects that the negotiated prices more than likely lie between the costs incurred by the co-generators and the benefits obtained by the utilities with the monopsony status of the latter giving them a strong upper hand in the negotiations. If this speculation is correct, the result would be significantly reduced incentives for firms to invest in co-generation capacity.

It is also very common to use block-declining (or more recently block-increasing) electricity tariffs that leave many customers on infra-marginal steps. Again, the same commodity can sell for a different price, while many consumers are inappropriately encouraged to consume when the cost of supply is highest.

Another common practice is geographically uniform pricing even though rural customers tend to be much more expensive to supply. For example, in Japan, consumer rates vary by voltage but not by location, yet customers in more remote and mountainous regions would be far more expensive to serve. Such cross-subsidies appear to be more closely related to the political influence of different consumer groups than to any economic factors. Geographically uniform pricing is particularly attractive to politicians since it appears to be non-discriminatory while it in fact represents a hidden subsidy from one group of consumers to another.

1.2.4 Non-price rationing and customer service

A problem governments often face when they attempt to force publicly owned firms to cross-subsidize consumers is that the firm may respond to the low prices by limiting the quantity or quality of services supplied to the subsidized group. In the electricity industry, non-price rationing takes the form of blackouts and brownouts (voltage or frequency fluctuations), delays in connecting new customers to the grid, and other forms of poor customer service.

Non-price rationing of demand is, however, likely to be less efficient than higher prices. When demand is reduced by prices, the least valuable uses of the good or service are eliminated first. All consumption that is valued at less than the price being charged is voluntarily foregone. With non-price rationing, there is no guarantee that the least valued demand is eliminated first.

Problems with poor customer service are exacerbated when the electricity supply firms are government-owned, or heavily regulated, monopolies. Such firms tend to be concerned primarily about delivering services as specified in a statute rather than meeting the demands of customers. By contrast, private competitive firms have an incentive to find and exploit any actions that can raise customer satisfaction.

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2 TECHNOLOGICAL CHANGE IN THE ELECTRICITY SUPPLY INDUSTRY

The arguments presented above regarding the balance between private and government ownership, or the degree of regulatory oversight of the electricity supply industry, for the most part cannot explain the recent *change* in attitudes toward the industry. Klein and Roger (1996) suggest that the different attitude is "disenchantment with the performance of regulated or nationalized firms." Admittedly, research from academic economists, the World Bank, the OECD and others has documented the relative inefficiency of public as opposed to private firms.[9] Nevertheless, factors other than evidence or experience have influenced the change in sentiment toward the role of regulation and public ownership in electricity supply.

2.1 Economies of scale in generation, co-generation, renewable energy sources

New technologies, particularly combined cycle gas turbines, have greatly reduced the economies of scale in building new electricity generating plant. There has also been extensive research into gasifying coal before using combined cycle gas turbine technology rather than simply burning the coal in a furnace to produce steam. Other technologies under investigation or development, such as stationary fuel cells, also display much smaller economies of scale than traditional coal-fired, oil-fired or nuclear plant. Similarly, many projects for utilizing renewable energy sources, such as wind, solar or wave power, typically involve generating plants that have a small capacity. Although these are unlikely to make a significant contribution over the next 10 to 20 years, they are major future forces.

Other trends have reinforced the tendency to build smaller generating plant. Environmental concerns have lead to an increased interest in using waste gases from coal mining or sewerage treatment, waste heat from industrial processes, and small hydroelectric plants to co-generate electricity. Most of these projects also involve low capacity generating plants.

A more competitive wholesale electricity market has become much more feasible as a result of the trend toward smaller capacity plants. More competitive markets in some countries have also encouraged technological development to proceed most rapidly in smaller scale electricity generating projects. The

market is very rapidly becoming one that can be supplied by many producers, each of whom would be looking for every opportunity to increase supply when electricity prices are high. In such a competitive commercial environment, there is less of a need for extensive government involvement or oversight of generators. Governments are also not ideally suited to bearing the increased commercial risks now inherent in the industry.

To take advantage of the competitive possibilities inherent in new technologies, however, wholesale electricity markets with many suppliers need to be established. In particular, it may be counter-productive to introduce wholesale markets for electricity but leave existing monopoly producers in place. Markets are very effective devices for revealing and communicating information about marginal costs and benefits, but if the market structure is uncompetitive then the information is defective. Employing a very efficient signaling device to send distorted information to private parties with freedom to react to those signals might produce a less efficient outcome than keeping tight centralized government control over an electricity industry organized along more traditional lines.

2.2 The falling costs of information technology

Advances in computer technology have been essential for developing competitive wholesale electricity markets. Generators need to be scheduled for supply or standby status on a continuous basis. This requires information on the geographical distribution of the demand load on the system as well as the capacity that each generating station could make available. The supply is then chosen to minimize costs while respecting constraints imposed by the capacities of the various transmission links and the need to maintain the electrical stability of the network. The information gathering and co-ordination problems associated with having many competing generating firms supplying each network could not have been solved without sophisticated computer capabilities.

In a competitive wholesale market, computers are also used to calculate the market-clearing price at regular intervals and to keep track of how much electricity market participants have bought or sold in each time period. Total payments then have to be calculated and accounts settled. The introduction of competitive wholesale electricity markets also has invariably increased the fluctuations in electricity prices. Market participants have in consequence turned to forward contracts as means of reducing risks. Such contracts could not have been developed without advanced computer technology that keeps track of differences between contracted and market clearing prices and the amounts of power that parties to each contract bought and sold at those prices.

When one firm uses the network of another firm in order to "wheel" electricity to a customer, the "wheeling charge" will depend on the amount of power transferred and may depend on the total load on the system at the time. Demand loads of each third party customer, along with the distribution of demands on the network as a whole, will need to be monitored and recorded on a continuous basis. If there were many such customers, the accounting would be infeasible without modern computer and communications technology.

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2.3 Advances in metering technology

The cost of sophisticated electricity meters, like the cost of computers, has been falling rapidly. It is now feasible for even moderate to low volume consumers to be charged prices that reflect the time-varying marginal costs of supply.

When consumers face time-varying prices, they have an incentive to change the time at which they draw power. This evens out the demand load on the system and reduces the need for expensive new generating capacity. Producers who can supply electricity at alternative times, such as those with pumped storage capacity, also have an incentive to increase supply when demand and prices are at their peak. As we noted above, this problem is particularly relevant in Japan because its load factor is one of the lowest among industrialized countries.

The benefits of sophisticated electricity meters are much greater in the context of a competitive wholesale electricity market where prices genuinely reflect marginal supply costs. Conversely, the benefits of knowing the current marginal costs of supplying electricity are much greater when those marginal costs can be passed on to consumers in the form of time-varying prices.

Once we have the capability to signal marginal costs to market participants at low cost, the foregone benefits of *not* taking advantage of this opportunity become so much greater. The falling cost of sophisticated electricity meters thus has increased the desirability of moving to a competitive wholesale electricity market.

It is important to emphasize in this context that the benefits of a wholesale market can be reaped only if that market is competitive. An uncompetitive wholesale market will produce prices that do not reflect marginal costs. Passing those distorted prices onto consumers through sophisticated metering devices would give consumers inappropriate signals about how they should modify their demand for electricity. An uncompetitive wholesale market with sophisticated metering devices could actually produce a worse outcome than a more traditional vertically integrated industry with regulated prices.

2.4 Transmission costs

Substantial technological changes in electricity transmission technology have increased the potential for competition in wholesale electricity markets. The current capacity of an 800 kV alternating current (AC) line is around 2000 MW. An anticipated figure for future 1200 kV lines is 5000 MW. A realistic maximum distance for an AC transmission is around 1200 km.

The recent technological breakthroughs, however, have been in high voltage direct current (HVDC) transmission. The most powerful HVDC transmission used today has a capacity of around 3000 MW, but an increase by a factor of at least two is within the capabilities of existing technology. From the Japanese perspective, a particularly important feature of HVDC transmission is that it would simplify power trading between the 50Hz eastern zone and the 60Hz western zone. Since the electricity needs to be converted to direct current before transmission and then re-converted to alternating current at the other end of the link, the differences in frequency in the two zones become irrelevant.

There are no practical limitations of line length for an HVDC line. A typical HVDC line design can have less than 50 percent of the losses associated with an AC line of the same power transfer capability. The per km construction costs of the HVDC line are also considerably less. However, the fixed terminal costs for HVDC equipment preclude the use of HVDC except for long lines or other special situations, such as the Japanese one, where frequency conversion cannot be avoided.

The falling cost of HVDC transmission has another important implication. It may become feasible, and economically attractive, for Japan to connect to the Asian mainland via the Korean peninsula in the next few decades. This would open the possibility for international trade in electricity. In particular, while Korea and Japan are on the same time zone, China is one hour behind. Differences in the timing of peak loads may make international trade in electricity more valuable. International trade in electricity would

also raise the incentive to make sure the Japanese electricity supply industry is competitive by world standards.

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3 REFORMING THE JAPANESE ELECTRICITY SUPPLY INDUSTRY

The electricity supply industry is undergoing substantial reform in most industrialized countries. The reforms have been associated with increased international trade in electricity (for example, there is now substantial trade between the U.S. and Canada and between the countries of Western Europe). The critical issue for Japan is whether it ought to join this process or retain its existing institutions.

3.1 The costs of forgoing reform

A possible danger for Japan, if it chooses to forgo the opportunity to join the reform movement, is that it may be left with an antiquated and uncompetitive industry when pressures to accept international trade in electricity become irresistible.[10] In the meantime, the very high cost of electricity supply in Japan inflicts substantial losses. As the efficiency of the industry increases in other countries, these losses are likely to mount. While the institutional reforms enacted in many countries have reflected technological change in the electricity supply industry, they have also stimulated further technological change. For example, the progress in combined cycle gas generation reflects in part the increased demand for smaller scale generating plant in a more competitive market environment.

At this juncture, it might be reasonable to ask whether the high costs of the existing institutional arrangement in Japan represent a real efficiency loss. One could argue, for example, that since the elasticity of demand for electricity is very low, artificially high prices simply represent a form of taxation of consumers that imposes few real costs. The efficiency costs imposed by a tax can be represented as in Figure 2.[11]

As demand for the product becomes less sensitive to price (that is, the price elasticity of demand declines) the efficiency losses (the shaded area in Figure 2) become very small. Consumers are made worse off by the tax, but the losses imposed on them approximate the revenue raised by the tax.[12] So long as there are no efficiency losses associated with dispensing that tax revenue, the tax would alter the distribution of income but impose small losses on the economy as a whole. The losses suffered by some would be counter-balanced by the gains accruing to the beneficiaries of the expenditure financed by the tax.

The high prices of electricity in Japan are not caused by an explicit tax on electricity consumption as illustrated in Figure 2, although the high costs of fuel result partly from a tax placed on competing fuels that is used to subsidize the domestic production of coal. The distortions resulting from government policy can be viewed, however, as *analogous* to a tax on electricity consumption. For example, the excessive technical standards imposed on Japanese utilities restrict the ability of suppliers from countries with different standards to compete. Such standards thus effectively allow Japanese suppliers to the domestic utilities to charge excessive prices. Equivalent outcomes could be achieved by explicitly taxing electricity consumption and using the revenue so raised to pay subsidies to the beneficiaries of the policies.

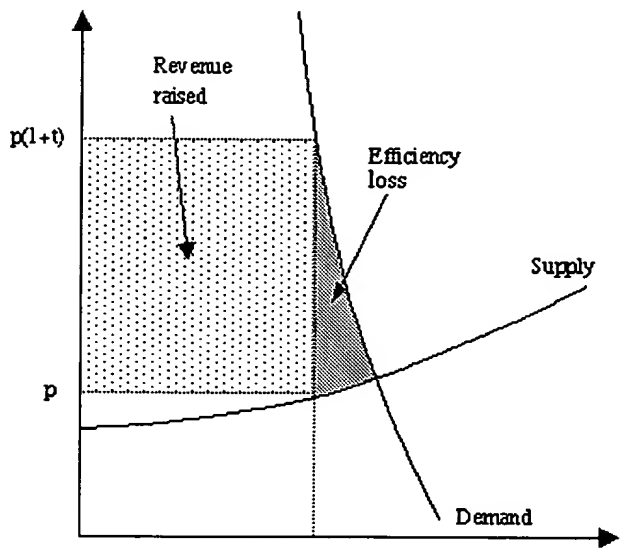

Figure 2: The efficiency costs of a tax

Like the efficiency losses from a tax, the cost of the policies affecting the Japanese electricity supply industry will be less the lower the elasticity of demand for electricity. Typically, elasticities of demand for electricity are estimated to be quite low. The amount of electricity consumed depends largely on the type of equipment a customer has and how much that equipment is used. In the short run, a price increase reduces demand primarily by encouraging reduced hours of use. In many cases, however, the cost of electricity is only a small part of the total costs of an activity. For example, a retail establishment needs to use electricity for lighting (the alternatives are not really very satisfactory). An increase in electricity prices may raise the costs of running the business, but the effect would not be great enough to cause the owner to operate the establishment for fewer hours. Electricity is, in most cases, not a sufficiently large component of costs for an increase in electricity prices of the magnitude we are talking about to make much of a difference to total costs. In the long run, higher electricity prices encourage consumers to alter the type of equipment they use, or alter the way they undertake their activities, in order to reduce the use of electricity. These adjustments do increase the efficiency losses of high electricity prices, but even then the elasticities are often not large.

The elasticity of demand for electricity can be quite high in particular industries. For example, electricity is the major expense in aluminum smelting, and an important component of costs in other refining operations. Some of these industries have, however, already relocated out of Japan, so the costs imposed by high electricity prices have already been incurred.

A more significant cost of the current Japanese policy is that, even if the overall demand for electricity is not very elastic, many customers can readily alter the *timing* of their demand. In addition, the marginal costs of supply vary substantially over time in an electricity system, such as the one in Japan, which is based substantially on thermal capacity. Consumers can have a high elasticity response to variations in prices over time periods. The efficiency losses of not having prices reflect marginal costs can therefore be quite high. In turn, there is virtually no way of determining the actual marginal costs of supplying electricity at each moment in time, and having those costs reflected in prices, except through the use of a decentralized competitive auction market.

Distortions in the mix of generating capacity used to supply electricity may also be a source of substantial efficiency losses. The technologies for producing electricity remained fairly stable for many

decades in the middle of the twentieth century. More recently, however, the electricity industry has experienced a much more rapid rate of technical change. This trend is likely to accelerate in coming decades as new technologies such as fuel cells or solar energy become more competitive with fossil fuel combustion. A major advantage of a market system in a changing environment is that one individual, organization or firm is rarely the fountain of all wisdom about the alternatives most likely to succeed among all those that are feasible. A competitive market encourages many firms to experiment with new technologies and the system can gradually adapt the solutions that are best suited to the market conditions. It is very difficult, if not impossible, to design the ideal system in advance. A central planner simply does not have all the knowledge or detailed information that would be necessary.

A related issue is that electricity now can be transported large distances at relatively low cost. Trade is an alternative to locally generating all the electricity needed to meet local demand. This is particularly important when regions differ in the nature of either their demand or their supply. Different regions are likely to have a different proportion of their electricity demand arising from industrial, transportation, and residential or commercial uses. In addition, firms in given industries often locate near each other to exploit so-called "economies of agglomeration."[13] A consequence is that regions tend to become specialized in certain types of industries, each with their own pattern of electricity demand.

When the pattern of electricity demand differs dramatically from one region to the next, substantial gains from trade may be possible. For example, a utility supplying a region that has a sharp peak in electricity demand may have substantial capacity that is not used for long periods of off-peak demand. That capacity could be used to generate electricity to be sold in other regions with different patterns of peak versus off-peak demands.

Regions can differ not only in their pattern of electricity demand but also in the resources available to generate electricity. Some regions may have more hydroelectric capacity, while others may have better ports making them more suitable for electricity generation based on imported coal. The northern areas of Japan may also be more suitable than more southern regions for electricity generation based on natural gas piped from Sakhalin or Siberia.

Different generating technologies typically have a different pattern of marginal costs as a function of output. For example, hydroelectricity and gas turbines are cheaper to start up or shut down, and thus are better suited to supplying peak demands on short notice. The ratio of capital to operating costs also affects the desirability of using capacity in peak versus off-peak periods. Differences in the structure of costs between regions would also allow for gains from inter-regional trade even if the patterns of demand were similar.

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3.2 The role of competition between generators

As the IEA (1999: 89) notes, "Developing competition in generation is the main purpose of reform of the sector." The major potential gains from reform result from reduced generating costs and prices that are more reflective of the marginal costs of production. Neither of these gains will be achieved without effective competition in generation.

If a wholesale market in electricity is introduced, but monopolies in the generating sector are left in place, the outcome may be worse than the current highly regulated system. Markets can be viewed as a mechanism to generate and transmit information. Prices signal to consumers the costs of meeting their demands and signal to producers the benefits of additional supply. Competition and freedom of entry

ensure that prices reflect the true costs of production. When supply is monopolized, however, prices will exceed production costs, and consumers and other potential producers will receive very defective signals about the value of changing their demand for, or supply of, electricity. When prices can only convey defective information to market participants, it may be better to make decisions in more of a "command and control" manner rather than relying on prices and decentralized markets. A partially reformed system thus could be less efficient than the current heavily regulated regime.

In the current electricity supply system in Japan, utilities have monopoly rights to transmit and distribute electricity within their allotted franchise areas. In some cases, industrial firms with co-generation capacity or local government authorities generate a modest amount of electricity for sale within the franchise area. These firms do not, however, directly supply consumers but must instead sell their output under contract to the monopoly utility. Their capacity is also a very small part of the total capacity in the franchise territory. The major potential competition for the current monopolies comes from the utilities in neighboring franchise areas.

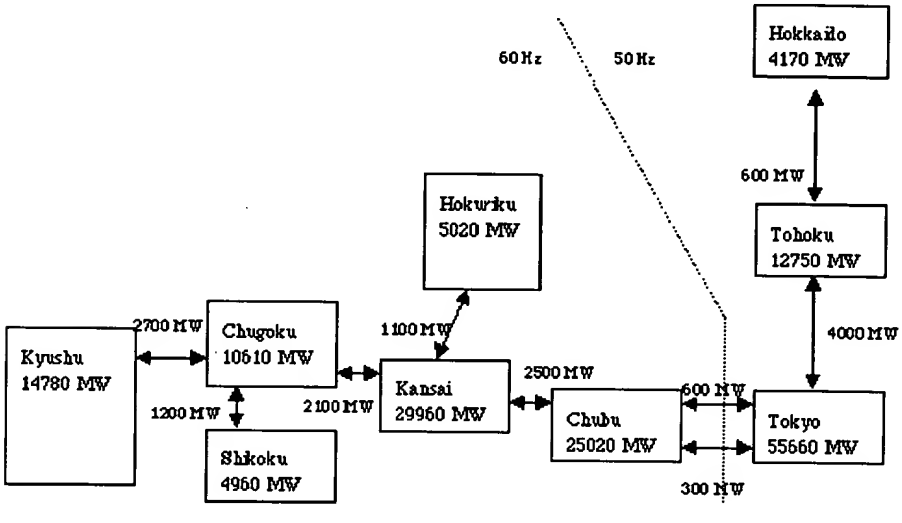

Figure 3: Transmission capacities and peak loads

Figure 3 (taken from IEA, 1999:94) illustrates the current generating capacities and transmission links between the nine major utilities in Japan.[14] The figure illustrates that the transmission links are of very low capacity relative to the total capacity of most of the utilities. At least during peak periods, when the total demand for electricity is close to the available generating capacity, most of the utilities thus do not face much competition from their neighbors. Increasing the capacities of the transmission links therefore could increase the competition between utilities. In particular, there is little doubt that the links between the 50Hz and 60Hz regions need to be strengthened.

The largest utility, Tokyo Electric Power Company (or Tokyo for short) could receive at most 8.8% of its peak demand from neighboring utilities. The next two largest utilities, Kansai and Chubu, could receive at most 19% and 13.6% respectively of their peak demand from their neighbors. The smaller utilities could be placed under more competitive pressure from their neighbors. The link between Chugoku and Kyushu is 18.3% of the peak load in Kyushu. For the northern island of Hokkaido, the corresponding figure is about 14%, while for Shikoku it is a little over 24%. The utility most exposed to potential competition is Chugoku, where almost 57% of the peak demand could potentially be supplied by the neighboring utilities. The links from Tokyo to the large utilities located to its west are particularly weak, most likely as a result of the frequency difference between the east and western utilities.

Upgrading the capacities of the links would not, however, introduce sufficient competition to enable an efficient wholesale market in electricity to be established. Only two of the nine utilities (Chugoku and Kansai) would face competition from three other generating companies. Three of them (Tohoku, Tokyo and Chubu) would face two competing firms, while the remaining four (Hokkaido, Hokuriku, Shikoku and Kyushu) would face just a single competing company. Independent suppliers within each franchise could be allowed to sell directly to consumers, but this likewise would do little to increase competition.

There are now quite a few examples of wholesale electricity markets in operation in a number of countries and under many different institutional and technological constraints. The general conclusion from examining these markets is that if any one generating company has capacity equal to 25% or more of the peak load capacity, the market is not sufficiently competitive to avoid serious price distortions and accompanying efficiency losses.

The only feasible way of obtaining a competitive wholesale electricity market in Japan is to require the monopoly utilities to divest themselves of at least two thirds of the generating capacity in their current supply region. With an additional 10% of power available from neighboring utilities, that would reduce the local utility's market share to around 25%.

In 1997, the nine major utilities together operated over 1100 hydroelectric plants, 165 thermal power stations and 14 nuclear power stations.[15] There is thus ample opportunity to introduce competition by requiring the utilities to sell off a majority of the plants located in their franchise areas. The neighboring utilities should not be permitted to buy the generating stations that are sold. Purchasers would instead need to be restricted to other Japanese utilities that are not currently competing with the divesting utility or else to new entrants from abroad. Licensing rules that restrict freedom of entry into generation should also be abolished. We can examine the generating assets of a few of the utilities to indicate what might be required to ensure adequate competition in a wholesale electricity market.

In March 1998, one of the smaller utilities, Shikoku, had one nuclear plant (with three reactors), four thermal plants (with one more under construction) and ten hydro stations. A tolerably competitive electricity market may be created on the island if the utility divested itself of all but the nuclear plant and one thermal station. The remaining four thermal plants and the hydro capacity would need to have separate owners.

As of July 1, 1999, the slightly larger utility, Hokuriku, operated one nuclear station, five thermal power stations (with one more under construction) and seven hydro stations with a capacity of 50MW or more. There were also two small thermal stations in its supply area run as co-operatives. Again, a reasonably competitive market would result if the utility were allowed to retain no more than two of its thermal plants and the remaining ones were sold to separate utilities other than Kansai (the only other producer linked to Hokuriku).

Also in 1999, one of the larger utilities, Chubu, operated one nuclear plant, 11 thermal plants and 18 hydro plants of more than 50 MW capacity. If Chubu were allowed to retain no more than three of its thermal and nuclear plants, the resulting market would most likely be reasonably competitive. One neighboring utility, Kansai (the second largest in terms of capacity), had three nuclear stations, 22 thermal stations and over 24 hydro stations. In this case, an adequately competitive market may still result if Kansai retained five of its nuclear and thermal stations.

The other neighbor of Chubu is the largest utility, Tokyo Electric. It operates on a different frequency to Chubu, however, and the link between them is quite small. In May 1997, Tokyo Electric had three nuclear stations, 25 thermal stations and over 156 hydroelectric stations. There is obviously substantial

scope for introducing greater competition into Tokyo Electric's franchise area. Before a wholesale market is established to serve the Tokyo area, Tokyo Electric ought to be required to divest itself of all but about 7 of its major generating stations.

The other utility we could obtain good information about was Chugoku. Recall that Chugoku faced the greatest competitive pressure from its neighbors with the potential to import almost 45% of the peak load from three connected utilities. In addition, Chugoku has three thermal power stations operated by other companies in its franchise area. The utility operates eight thermal power stations (apart from three small stations on outlying islands), one nuclear plant and 30 hydro stations of 10 MW or more capacity. Once again, an adequately competitive market could be obtained by requiring the utility to divest itself of all but two of its large thermal or nuclear stations.

Competition also can be impaired when a utility owns the high voltage transmission network in addition to a substantial fraction of the generating capacity. Ideally, the utilities should be required to sell off their transmission and distribution businesses. Other jurisdictions, such as the state of California in the U.S., have established an independent system operator. The system operator schedules competing generating companies to meet the demand for power at each moment. This cannot be done simply by choosing those firms willing to supply at the lowest price, since maintaining system stability requires a balancing of supplies and demands at different locations on the network. These qualitative judgements are more difficult for other firms, or a government regulatory agency, to monitor. A system operator that also owns substantial generating capacity will have a serious conflict of interest when deciding which generating firms ought to be chosen to supply power at each moment.

If utilities are allowed to keep their transmission lines, there also need to be transparent rules for pricing transmission capacity. Independent generators forced to pay exorbitant charges for "wheeling" power to customers will be placed at a severe disadvantage relative to the monopoly utility. In order to provide appropriate incentives for co-generation of electricity, utilities ought to be required to pay the same price for electricity supplied at a given location and at a given voltage as they charge for electricity demanded at that same location and voltage. The marginal value of electricity at each location on the high voltage transmission network is the same whether electricity is being bought or sold at that point.

It might be thought that anti-monopolies law is sufficient to constrain the exercise of monopoly power. One could just establish a wholesale market without intervening at all in the structure of the industry. This was more or less the approach taken by New Zealand when it corporatized its government owned electricity supply firm (Electricorp). More recently, however, the New Zealand government has decided that a wholesale electricity market cannot be adequately competitive without splitting Electricorp into three separate competing firms. The anti-monopolies law and freedom of entry for new generating companies were not enough to constrain the exercise of monopoly power in the short run. If freedom of entry is ensured, new competitors may, in the longer term, solve monopoly problems. One can argue that this process is occurring in the U.K.. In the meantime, however, there is also substantial evidence of efficiency losses associated with the exercise of monopoly power.

Another important issue is the sequencing of reforms. The government would need to establish the new regulatory structure and rules for entry, and delineate any changes to the transmission network, before any assets are sold.

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3.3 Obstacles to reform

A major obstacle to reform in Japan is that private companies currently own most of the facilities. By comparison, reform was much easier in countries such as the U.K., Argentina and Australia because the government originally owned the facilities and could decide how to restructure the industry before privatizing. California presents a situation parallel to the Japanese one. In that case, the government only agreed to continue support for recovery of "stranded costs"[16] if the firms agreed to sell off a substantial part of their generating capacity.

The utilities in Japan are also in need of continued government action to keep their existing operations profitable. As in the case of California, government support could be made contingent on the firms agreeing to establish a more competitive market structure.

Nuclear power may represent another major impediment to reform in Japan. The Japanese government has promoted nuclear power as a means to reduce Japanese dependence on energy imports. While uranium needs to be imported, fissionable materials can be recovered from nuclear waste and re-used. The build-up of plutonium and other by-products resulting from nuclear power becomes a domestic energy resource.[17]

As of February 1999, Japan had 51 reactors providing more than a third of total electricity output.[18] It is now the third largest producer of nuclear energy after the U.S. and France. According to the IEA, the government plans to raise the proportion of electricity generated by nuclear power to 42% by 2010. This would be achieved by the construction of between 16 and 20 new reactors. The IEA notes, however, that nuclear plants are unlikely to be competitive in a deregulated electricity market. If the government wishes to pursue the development of nuclear power, therefore, subsidies most likely would be needed.[19] It is not necessary, however, to retain a regulated market in order to implement subsidies for nuclear power. The government could impose a tax on electricity consumption that could be used to pay for direct subsidies of nuclear power if that is thought to be desirable.

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4 CONCLUDING REMARKS

The Japanese government has expressed some concern about the lack of competitiveness of its electricity industry. A Committee on Basic Policy of the Electric Utility Industry Council produced a report in May 1998 at the request of the government. The Committee ruled out the introduction of a wholesale electricity market. It instead recommended partial liberalization of the retail market.

It is absolutely the wrong policy to focus on freeing up the retail market while retaining monopoly power in the generation sector. The real efficiency gains arise from reforming the generation sector and the wholesale market for power, not the retail market. In particular, the major gains from freeing up the retail market arise from having customers face prices that better reflect the marginal costs of supply. These costs are, however, impossible to determine in the absence of a competitive wholesale electricity market.

The 1995 Amendments to the Electric Utilities Industry Law liberalized entry rules for independent power producers (IPPs) and required utilities to conduct tenders to meet additional thermal power needs. These changes have encouraged entry of IPPs, while the two tenders conducted to date reduced costs by between 10 and 40% below the "upper limit prices" calculated by the utilities. Such marginal increases in competition are, however, not a sufficient foundation for introducing a wholesale market in electricity. Much more radical reforms are required.

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[1] For simplicity, the figure ignores the costs associated with operating the network. In the case of electricity, these will be primarily the transmission losses due to electrical resistance. Allowing for these costs would not affect the issue under discussion.

[2] If the monopolist can charge different prices to upstream or downstream suppliers or purchasers, it could increase profits while expanding supply toward the efficient level. The monopolist's suppliers or customers are, however, likely to be made worse off by such price discrimination. The upstream or downstream firms may conceal information to make price discrimination less feasible or effective. Vertical integration may alleviate these asymmetries in information and benefit consumers as well as the monopoly network provider.

[3] In the present context, it is important to distinguish economic efficiency from engineering efficiency in general and energy efficiency in particular. It generally would not be efficient in the economic sense to minimize the energy input per unit of production or per unit of other inputs to the productive process. The costs of using energy versus other factors of production, such as labor or capital, should instead equate the marginal productivity of each of these factors to its marginal cost. Similarly, consumers will in general desire to trade-off lower energy costs for other product features.

[4] As with energy efficiency, technical standards can be too high from an economic perspective. Safety and related concerns should only be pursued up to the point where the marginal costs balance the marginal benefits. It is possible to be "too safe" as anyone who chooses to drive a car acknowledges.

[5] Under pumped storage, relatively cheap off-peak electricity is used to pump water to a dam located at a high elevation. The water is then used to generate electricity as it flows back to a dam at a lower elevation during peak periods. In effect, this allows cheaper base load capacity to be used to supply additional power during peak periods when electricity would otherwise be more expensive to produce. The alternative type of hydroelectric capacity is run-of-river plant that must be used continuously.

[6] The capacity factor is the actual annual electricity generated by a plant divided by the potential amount

of electricity that could be supplied were the plant to be operated continuously throughout the year.

[7] This is not to say, however, that multi-part prices with fixed charges or infra-marginal price steps cannot be even more efficient than simple per unit prices equal to marginal costs for all units consumed.

[8] The load factor is measured as the ratio of the actual amount of power consumed annually to the amount that would be consumed if the demand were instead to remain constant at its peak level throughout the year. It is thus a measure of the extent to which demand fluctuates between peak and off-peak periods.

[9] See, for example, Bishop and Kay (1988), Boardman and Vining (1989), Shirley and Nellis (1991), Kikeri, Nellis and Shirley (1992), Galal, Jones, Tandon and Vogelsang (1994) and Megginson, Nash and van Randenborgh (1994). The authors of a recent World Bank Report (1995) note that the best empirical work compares the performance of publicly owned enterprises before and after privatization, divested with publicly owned enterprises, or divested firms with a hypothetical situation in which the same firm is assumed to continue under public ownership. They conclude (p. 37) that,

> In competitive markets this literature gives the edge to the private sector ... Where (the enterprises) operate in uncompetitive markets, the results and interpretations are less clear.

In one study where privatizations improve welfare in 11 out of 12 cases, the authors note (p. 38) that,

> The gains came primarily from improved productivity, increased investment, and better pricing; they occurred in both competitive and monopoly markets in part because the regulatory framework for the monopolies was sound enough to allow private firms to function efficiently and to protect consumers.

[10] As we noted above, it may become practical to trade electricity between Japan and mainland Asia in the not too distant future.

[11] While this partial equilibrium framework for evaluating the losses from a tax is a simplification, it nevertheless captures the key idea that losses depend on the elasticities of supply and demand.

[12] If demand is completely inelastic (so it does not respond at all to a price change) the loss to consumers as a result of the tax becomes equal to the revenue raised by the tax. The efficiency loss triangle in Figure 2 disappears and the price received by producers does not change. The full burden of the tax falls on consumers.

[13] The different firms in a given industry may relay on a common labor pool, the same suppliers of parts or components or common transport facilities. These factors can make it ideal for firms to locate near other firms in the same industry.

[14] The system on the island of Okinawa is isolated from the rest of the network.

[15] The thermal power stations each had more than one generating unit and the nuclear stations more than one reactor.

[16] These are costs incurred under the previously regulated environment that amount to "excessive" costs in a more competitive market. In the California case, some of these stranded costs also arose because of excessively optimistic forecasts for demand growth in the years immediately preceding the reforms.

[17] In an extreme situation, plutonium may also have strategic value for a Japan living next to other large nuclear powers and lacking full confidence in the extent to which the US would be willing to make sacrifices on Japan's behalf.

[18] The locations, capacities and dates of first commercial operation of each reactor are available at http://www2.enecho.go.jp/atom/jyoho/atomnet/E/general/atomic/ke01.html

[19] One argument used to support continued development of nuclear power is that this would enable Japan to meet its commitments, under the Kyoto protocol, to reduce greenhouse gas emissions. Given the current state of knowledge on the global warming issue, it is debatable whether Japan (or any other

country) ought to take costly measures to meet those commitments. One also could argue that Japan already has "carbon taxes" in the form of taxes on gasoline, natural gas and oil used for electricity generation, and the high price of coal. The key point for the current discussion, however, is that whether or not subsidies to nuclear power are justified, if they are desired they can be imposed in a deregulated market simply by taxing the use of fossil fuels to generate electricity and using the revenue to subsidize nuclear power.

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